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(Translation)

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[Title of the Invention] Electrophoresis display device

[Claims]

[Claim 1] An electrophoresis display device, in which at least one pair of substrates respectively including electrodes are located opposed to each other, the electrodes are facing each other, and the substrates and a partition form a closed space; at least one of the electrodes facing each other and at least one of the pair of substrates are formed of a transparent material; and the closed space accommodates a plurality of microcapsules encapsulating an electrophoresis display liquid containing a liquid phase dispersion medium and electrophoresis particles and a dispersion material for dispersing the microcapsules in the closed space,

wherein a dielectric constant of the electrophoresis display liquid and a dielectric constant of the dispersion material are substantially identical with each other.

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[Claim 2] An electrophoresis display device according to claim 1, wherein the dispersion material contains at least one of alcohols, ketones and carboxylic acid salts for adjusting the dielectric constant.

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

The present invention relates to an electrophoresis display device which operates utilizing that charged particles in a medium move by an application of a voltage.

[0002]

[Prior Art]

An electrophoresis display device 20 shown in Figure 3 is conventionally known. The electrophoresis display device 20 includes two substrates 21 and 22 located opposed to each other while being distanced from each other by a prescribed length by partitions 23. At least one of the substrates 21 and 22 is formed of a light-tranamissive material, for example, glass. A closed space 24 is formed by the glass substrates 21 and 22 and the partitions 23. The pair of glass substrates 21 and 22 have flat transparent electrodes 25 and 26 fixed on inner surfaces thereof. The electrodes 25 and 26 are formed of, for example, ITO. A dispersion liquid 27 for electrophoresis display is contained in the closed space 24. The dispersion liquid 27 for electrophoresis display contains a colored dispersion medium 27a colored, for example, black and white charged particles 27b (electrophoresis particles; e.g., white pigment) dispersed in the dispersion medium 27a.

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[0003]

Such an electrophoresis display device 20 operates in the following manner. When, for example, a positive voltage is applied to the upper electrode 25 and a negative voltage is applied to the lower electrode 26 as shown in Figure 4(A), the negatively charged white pigments 27b migrate toward an anode by the Coulomb force and adhere to the upper, positive electrode 25. When the electrophoresis display device 20 in such a state is observed from the position of the eye shown in Figure 4(A), a layer formed of the white pigments 27b appears white through the transparent electrode 25 and the glass substrate 21. When the voltage is applied in an opposite manner, the white pigments 27b adhere to the electrode 26 on the other side to form a layer as shown in Figure 4(B). When the electrophoresis display device 20 is observed from the position of the eye shown in Figure 4(B), the electrophoresis display panel appears black because the layer of the white pigments 27b is behind the black dispersion medium 27a. Once the white pigments 27b adhere to the electrode, it is not necessary to apply the voltage other than for maintaining the adhesion.

[0004]

However, the above-described electrophoresis display device 20 has problems in that the charged particles (electrophoresis particles; e.g., white pigments) may aggregate or that the adhesion may cause non-uniform display. In order to solve such problems, Japanese Laid-Open Publication No. 64-86116, for example, proposes an electrophoresis display device including a great number of

spherical microcapsules each encapsulating a dispersion system containing charged particles in a dispersion medium by a microcapsulating technique and a binder for filling the gap among the microcapsules. Such an electrophoresis display device solves the above-described problem of non-uniform display to some extent so as to improve the display resolution.

[0005]

[Problems to be Solved by the Invention]

However, in such an electrophoresis display device using the microcapsules, when the dielectric constant in the microcapsules and the dielectric constant of the binder are different, the electric field in the microcapsules becomes non-uniform by an influence of the dielectric polarization, since the microcapsules are spherical. As a result, the charged particles are localized in the microcapsules, which prevents sufficiently high display quality. Specifically, for example, when the dielectric constant of the binder is lower than the dielectric constant in the microcapsules having a high dielectric constant, the elactric field in a central area of the microcapsules is weakest by an influence of the dielectric polarization. As a result, as shown in Figure 5, charged particles 32 are localized in the vicinity of a side area of the surface of a microcapsule 31, where the electric field is relatively strong. Accordingly, a central area 34 of the microcapsule 31 has only a dispersion medium 33 and is devoid of charged particles. Thus, the contrast is lowered.

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[0006]

The present invention has an objective of providing an electrophoresis display device having a satisfactory display quality.

[0007]

[Means for Solving the Problems]

An electrophoresis display device according to the present invention has a structure in which at least one pair of substrates respectively including electrodes are located opposed to each other, the electrodes are facing each other, and the substrates and a partition form a closed space; at least one of the electrodes facing each other and at least one of the pair of substrates are formed of a transparent material; and the closed space accommodates a plurality of microcapsules encapsulating an electrophoresis display liquid containing a liquid phase dispersion medium and electrophoresis particles and a dispersion material for dispersing the microcapsules in the closed space. A dielectric constant of the electrophoresis display liquid and a dielectric constant of the dispersion material are substantially identical with each other.

[0008]

In the electrophoresis display device according to the present invention, the dispersion material preferably contains at least one of alcohols, ketones and carboxylic acid salts for adjusting the dielectric constant.

[0009]

In an electrophoresis display device according to the

present invention, the dispersion medium and the electrophoresis display liquid in the microcapsules have a substantially equal dielectric constant. Therefore, the electric field generated in the vicinity of the surface of the microcapsule can be made uniform. Thus, localization of the charged particles in the microcapsule occurring by the non-uniform electric field is suppressed. As a result, the electrophoresis display device according to the present invention provides a high quality display.

[0010]

[Examples]

Hereinafter, an example of an electrophoresis display device according to the present invention will be described in detail with reference to the figures. Figure 1 is a cross-sectional view of an electrophoresis display device 1 in one example according to the present invention. As shown in Figure 1, the electrophoresis display device 1 includes a light-transmissive transparent substrate 2 and a non-light-transmissive back substrate 3 located opposed to each other while being distanced from each other by a prescribed length by partitions 9 which are located at right and left ends of the substrates 2 and 3. A closed space 10 is formed by the transparent substrate 2, the back substrate 3 and the partitions 9. The transparent substrate 2 is formed of, for example, a transparent synthetic resin such as PET. The back substrate 3 can be formed of a light-transmissive material instead of a non-light-transmissive material.

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[0011]

The transparent substrate 2 and the back substrate 3 have transparent electrodes 4 and 5 formed on opposing surfaces thereof. The transparent electrodes 4 and 5 are formed of, for example, ITO. A great number of microcapsules 6 are encapsulated in the closed space 10 between the transparent electrodes 4 and 5. The microcapsules 6 are spherical and each encapsulate a dispersion system containing charged particles 7 dispersed in a dispersion medium 11 by a microcapsulating technique. Hereinafter, a mixed liquid of the charged particles 7 and the dispersion medium 11 encapsulated in the microcapsules 6 will also be referred to as an electrophoresis display liquid. The dielectric constant of the electrophoresis display liquid is, for example, 6.5 F/m. The dielectric constant of the electrophoresis display liquid is a fixed value determined by the selected charged particles 7 and dispersion liquid 11.

[0012]

A binder 8 for dispersing the microcapsules 6 is contained in the closed space 10. The binder 8 is preferably transparent and aqueous, and has a satisfactory adhesiveness with the transparent electrodes 4 and 5. The binder 8 is formed of, for example, a silicone compound and has a dielectric constant of, for example, 2.9 F/m. The binder 8 can also be formed of, for example, acrylic, ester, and urethane materials which fulfill the above-described conditions of transparency, aqueousness and adhesiveness. In this example, a material which is aqueous, and transparent when being mixed with the binder

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8, for example, alcohol, ketone or carboxylic acid salt, is mixed with the binder 8, so that the dielectric constant of the binder 8 is adjusted to be substantially equal to the dielectric constant of the electrophoresis display liquid in the microcapsules 6. Usable alcohols include, for example, 1,2-buthanediol, 1,4-buthanediol and glycerin.

[0013]

Since the binder 8 and the electrophoresis display liquid in the microcapsules 6 have substantially the same dielectric constant, the electric field generated in the vicinity of the surface of the microcapsules 6 by the transparent electrodes 4 and 5 is uniformized. Thus, the localization of the charged particles 7 caused in the microcapsules 6 by the non-uniform electric field is suppressed. In other words, as shown in Figure 2, the charged particles 7 are distributed properly in a central area 34 in the microcapsule 6. As a result, the electrophoresis display device 1 provides a high quality display.

[0014]

[Examples]

In this example, the electrophoresis display liquid encapsulated in the microcapsules 6 was formed by mixing 12 parts of zinc sulphate, 1.5 parts of surfactant span 38, 0.5 parts of titanium coupler, 1 part of blue anthraquinone dye, and 85 parts of hexylbenzene by supersonic dispersion and adjusting the resultant mixture to have an average diameter of 35 microns by a composite coacervation method of arabic gum gelatin. The binder 8 was formed of an

emulsion of a silicone compound. As a dielectric adjusting agent, 1,4-buthanediol was used and mixed in only 8 parts with respect to the binder 8.

[0015]

The binder 8 and the microcapsules 6 were mixed at the ratio of 1:2 and adjusted into a slurry containing about 50 wt.% of water. For comparison, a sample containing no 1,4-buthanediol was prepared. The electrophoresis display device 20[sic] shown in Figure 1 was produced using a roll coater and a roll laminator. The transparent substrate 2 was formed of a PET film having a thickness of 50 μm coated with an ITO film. It was confirmed by an optical microscope that the charged particles 7 were electrophorasing in the entire region in the microcapsules 6 at a DC voltage of 50 V, which indicates very satisfactory display.

[0016]

[Effect of the Invention]

As can be appreciated from the above description, the dispersion material and the electrophoresis display liquid in the microcapsules have substantially the same dielectric constant in an electrophorasis display device according to the present invention. Therefore, the dielectric field generated in the vicinity of the surface of the microcapsules can be uniformized. Thus, the localization of the charged particles occurring in the microcapsules by the non-uniform electric field is suppressed. As a result, the electrophorasis display device according to the present invention provides high quality display.

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[Brief Description of the Drawings]

[Figure 1] Figure 1 is a cross-sectional view of an electrophoresis display device in an example according to the present invention.

[Figure 2] Figure 2 shows the distribution state of charged particles in a microcapsule in the electrophoresis display device shown in Figure 1.

[Figure 3] Figure 3 is a vertical cross-sectional view of a conventional electrophoresis display device.

[Figure 4] Figure 4 shows the operation state of the conventional electrophoresis display device. Figure 4(a) shows a first state, and Figure 4(b) shows a second state.

[Figure 5] Figure 5 is a view for explaining the problems involved in the conventional electrophoresis display device and shows the distribution state of charged particles in a microcapsule.

[Description of the Reference Numerals]

1 ... Electrophoresis display device
2 ... Transparent substrate
3 ... Back substrate
4, 5 ... Transparent electrode
6 ... Microcapsule
7 ... Charged particle
8 ... Binder
9 ... Partition
10 ... Closed space

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11 ... Dispersi n medium

Fig. 1

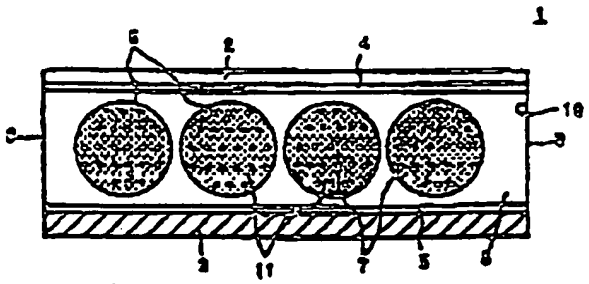


Fig. 2

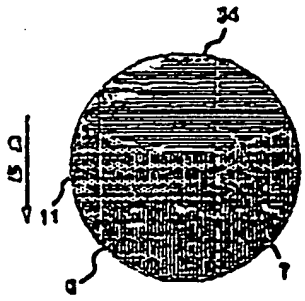


Fig. 3

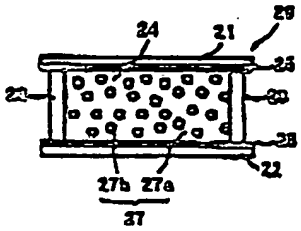


Fig. 4

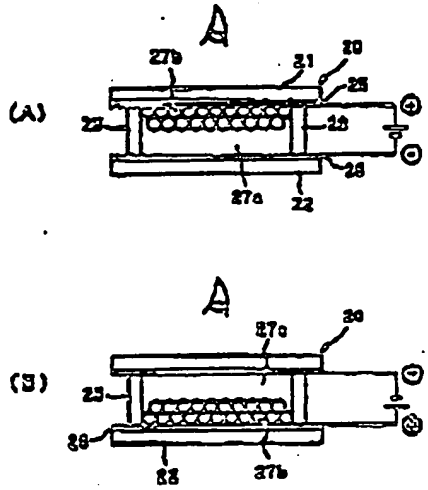
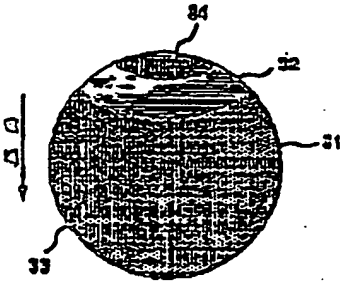


Fig. 5



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[Abstract]

[Objective] Providing an electrophoresis display device having a satisfactory display quality.

[Means for Achieving the Objective] A light-transmissive transparent substrate 2 and a non-light-transmissive back substrate 3 are located opposed to each other while being distanced from each other by a prescribed length by partitions 9 located at right and left ends of the substrates 2 and 3. A closed space 10 is formed by the transparent substrate 2, the back substrate 3 and the partitions 9. A great number of microcapsules 6 are contained in the closed space 10 between transparent electrodes 5 and 6. The microcapsule 6 is spherical and each encapsulate a disperaion system containing charged particles 7 dispersed in a dispersion medium 11 by a microcapsulating technique. The dielectric constant of the electrophoresis display liquid including the charged particles 7 and the dispersion medium 11 and the dielectric constant of a binder 8 are substantially equal to each other.